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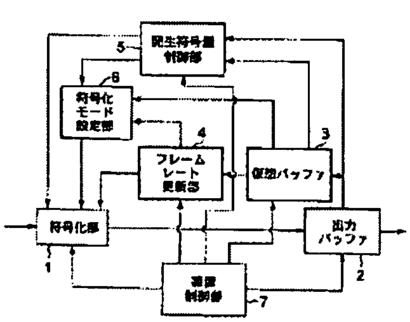
Abstract:
PROBLEM TO BE SOLVED: To provide a moving picture encoder capable of enhancing view quality of a moving picture so as to smoothly reproduce a stable moving picture.SOLUTION: An encoding mode setting section 6 estimates a generated code amount when one picture is intra-coded and also estimates a buffer occupied amount of a virtual buffer when the generated code amount is removed. The encoding mode setting section 6 estimates a frame rate on the basis of the estimated buffer occupancy amount. A device control section 7 designates a desired frame rate. The moving picture encoder decides whether or not a difference between the estimated frame rate and the designated frame rate is a prescribed or more and executes the intra-coding when the decided difference of the frame rate is less than the prescribed value or executes the inter-coding when the decided difference of the frame rate is the prescribed value or more, as its control.



JPO Machine translation abstract:

(57) **Abstract**
SUBJECT The quality of the appearance of video is raised and that the smoothly stable video is reproduced aims at providing the video coding equipment which becomes possible.
Means for Solution The coding mode set part 6 presumes a generated code amount when one picture is formed into a screen inner code. Buffer occupied quantity of a virtual buffer when this generated code amount is removed is also presumed. The coding mode set part 6 is based in this presumed buffer occupied quantity, and presumes a frame rate. The device control part 7 specifies a desired frame rate. It is judged whether a difference of a presumed frame rate and said frame rate specified is beyond a predetermined value. It is based on video coding equipment controlled to perform screen inner code-ization when a difference of a judged frame rate is less than a predetermined value, and to perform coding by the coding between screens when a difference of said judged frame rate is beyond a predetermined value.

Claim(s)
Claim 1 Video coding equipment which performs coding while referring to a virtual buffer characterized by comprising the following for guessing an occupation of a buffer by the side of decoding.
A generated code amount estimation means which presumes a generated code amount when one picture is formed into a screen inner code.
A buffer-occupied-quantity estimation means which presumes buffer occupied quantity of said virtual buffer when a generated code amount presumed for said one picture is removed.
A frame rate estimation means which is based in said presumed buffer occupied quantity, and presumes a frame rate.
A frame rate setting means which specifies a desired frame rate.
Said presumed frame rate.
A frame rate judging means which judges whether a difference with said frame rate specified is beyond a predetermined value.
An encoding control means to control to perform screen inner code-ization when a difference of said judged frame rate is less than a predetermined value, and to perform coding by the coding between screens when a difference of said judged frame rate is beyond a predetermined value.

Claim 2 By measuring a setting-out means to set a threshold as a virtual buffer, and buffer occupied quantity of said virtual buffer immediately after coding the threshold concerned and one picture, The video coding equipment according to claim 1 providing further a frame rate update means which updates a frame rate.
Claim 3 The video coding equipment according to claim 2, wherein said setting-out means sets two or more thresholds as buffer occupied quantity.
Claim 4 Said frame rate update means are two or more fields divided by threshold which has the lowest value from a threshold which has the largest value among said two or more thresholds, The video coding equipment according to claim 3 updating so that it belongs to a field where buffer occupied quantity of said virtual buffer immediately after coding one picture is low, and a frame rate may become low in order.
Claim 5A frame number calculating means which computes the number of frames formed into the screen inner code by within a time **with the past** , The video coding equipment according to any one of claims 1 to 4 providing further a control means controlled to perform coding between screens when said frame number is more than a predetermined number, a frame number judging means which judges whether said computed frame number is less than a predetermined number, and.

Detailed Description of the Invention
0001
Field of the Invention This invention relates to the video coding equipment for elongating the video compressed especially about the video coding equipment for compressing video or elongating the compressed video, and outputting a clear picture.
0002
Description of the Prior Art With the video coding equipment in this invention. ITU-T (International.) H.26x and ISO/IEC (International Standards Organization/International.) of Telecommunication Union-Telecommunication sector advice It is a device for coding video with the video coding mode represented by standard MPEG (Moving Picture Experts Group) for Electrotechnical Commission. That is, video coding equipment performs coding per frame using a motion compensation, orthogonal transformation (for example, discrete cosine transform), etc.
0003 Generally, to the video signal inputted, the video coding mode represented by MPEG H.26x of an ITU-T recommendation and standard for ISO/IEC is spatial, and applies compression with temporal correlation. Based on the data obtained by this compression, according to the given order, variable length coding is performed further, and a code sequence (bit stream) is generated.
0004 Video coding equipment must output the bit stream of the code amount specified according to the predetermined encoding parameter. Furthermore, in the buffer by the side of a decoder, a generated code amount must be controlled by the encoder side supposing the occupation of the buffer by the side of a decoder so that neither overflow nor underflow arises. This buffer is called a VBV (Video Buffering Verifier) buffer. It may only be called a virtual buffer. As for the capacity of the VBV buffer, upper limit was decided by MPEG-4 with the profile and the level. A generated code amount is controlled by the quantizing scale used in order to quantize the discrete cosine transform (DCT:Discrete Cosine Transform) coefficient obtained as a result of DCT's being performed by every macro block (MB:MacroBlock) in a frame. Generally, a generated code amount and a quantizing scale have a relation of reverse proportion. It is possible to change a generated code amount free using this character.
0005 However, since a quantizing scale generally has restriction, it is impossible to control a generated code amount only by a quantizing scale. Then, when there are more generated code amounts than a desired value, the number of frame skips is increased. By increasing the number of frame skips, the frame which should be coded can be delayed and the underflow of a VBV buffer can be prevented. Stuffing is performed when there are few generated code amounts than a desired value. Stuffing is inserting a redundant bit and prevents overflow of a VBV buffer.
0006 Drawing 1 is a figure showing the conventional method of controlling a virtual buffer, and shows the buffer occupied quantity of the virtual buffer to time. As the control method of a frame skip, the boundary value (B (min)) in a VBV buffer is established. The amount of buffers is made to increase by skipping until it increases the number of frame skips when less than this (time t_4 shown in drawing 1), and it exceeds a boundary value.
0007
Problem(s) to be Solved by the Invention However, according to this method, when a state with many generated code amounts continues, a state with little buffer occupied quantity continues, and buffer occupied quantity moves the boundary-value circumference up and down. For example, it moves up and down like time t_4 shown in drawing 1, and time t_5. Therefore, the operation which increases the number of frame skips and recovers a buffer, and operation of a predetermined frame skip are repeated. As a result, it will be in a state with an unstable frame interval, and quality will worsen dramatically also at appearance.
0008 In consideration of improvement in image quality, error tolerance, and random access nature, I-VOP (I-VOP:Intra-Video Object Plane) may be inserted into a bit stream. Since I-VOP has comparatively many code amounts, a VBV buffer will become an underflow tendency if I-VOP is inserted frequently. There is a problem that the number of frame skips increases rapidly, by inserting I-VOP around said boundary value.
0009 Then, the video where the purpose of this invention raised the quality of the appearance of video and which was stabilized smoothly being reproduced in view of the problem in these former is providing the video coding equipment which becomes possible.
0010
Means for Solving the Problem In video coding equipment which according to this invention performs coding while referring to a virtual buffer for guessing an occupation of a buffer by the side of decoding, A generated code amount estimation means which presumes a generated code amount when one picture is formed into a screen inner code, A buffer-occupied-quantity estimation means which presumes buffer occupied quantity of said virtual buffer when a generated code amount presumed for said one picture is removed, A frame rate estimation means which is based in said presumed buffer occupied quantity, and presumes a frame rate, A frame rate setting means which specifies a desired frame rate, and said presumed frame rate, A frame rate judging means which judges whether a difference with said frame rate specified is beyond a predetermined value, An encoding control means to control to perform screen inner code-ization when a difference of said judged frame rate is less than a predetermined value, and to perform coding by the coding between screens when a difference of said judged frame rate is beyond a predetermined value, It is provided by providing video coding equipment.
0011 This video coding equipment predicts a virtual buffer after I-VOP coding, and when changing sharply a frame rate obtained from that predicted value from the present frame rate, it does not code I-VOP.
0012 Two or more control points are formed in a virtual buffer, and a frame rate updating section which sets up a different frame rate for every point of the is

provided. This frame rate set up every two or more points is sent to a coding part of video, and a coding part codes by skipping a picture inputted according to a specified frame rate.
0013 The number of I-VOP which should be contained within predetermined time from buffer occupied quantity of a virtual buffer is controlled, and buffer underflow is controlled.
0014
Embodiment of the Invention Hereafter, with reference to Drawings, the embodiment of the video coding equipment of this invention is described.
(A 1st embodiment) Drawing 2 is a functional block diagram showing the electric internal configuration of the video coding equipment in a 1st embodiment. The video coding equipment of this invention consists of the coding part 1, the output buffer 2, the virtual buffer 3, the frame rate updating section 4, the generated code amount control section 5, the coding mode set part 6, and the device control part 7.
0015 The coding part 1 inputs the picture signal which should be coded from a picture input device. A picture input device is a signal source of a dynamic image signal like a digital video camera or recording playback apparatus. The inputted picture signal is coded according to predetermined video compression technology, i.e., MPEG-4 standard method for ISO/IEC and H.263 method of an ITU-T recommendation, or the method which changed these. Coding divides each frame contained in the inputted picture signal into a predetermined macro block according to video compression technology. From the coding mode set part 6, the coding mode (intra coding or inter encoding) which codes each macro block is inputted.
0016 Below, the video coding mode in MPEG-4 (Moving Picture Experts Group Phase 4) is described. A video signal comprises two or more video object plains (VOP:Video Object Plane). In the case of rectangular shape, VOP is equivalent to the frame and the field in MPEG-1 and 2. Spatial per VOP and it compresses with temporal correlation. VOP has a luminance signal and a color-difference signal, and comprises two or more MB(s). MB consists of 16 pixels of every direction to a luminance signal. Spatial compression and time compression are performed by this MB unit. A picture is compressed by DCT and quantization in spatial compression. A picture is compressed by the motion compensation (MC:Motion Compensation) in time compression.
0017 The compression method of a VOP unit has the formation of a screen inner code (intra coding) coded only by spatial compression, and the coding between screens (formation of interchange agreement) coded by spatial compression and time compression. VOP formed into the screen inner code is called I-VOP (Intra-VOP). VOP coded between screens has two kinds such as P-VOP (Predictive-VOP) and B-VOP (Bi-directionally predictive-VOP). Only VOP before coded in time as the reference VOP is VOP referred to, and P-VOP is VOP which MC of the uni directional was performed and was coded. VOP coded forward and backward in time as the reference VOP is VOP referred to, and B-VOP is VOP which bidirectional MC was performed and was coded. In the reference VOP, it is VOP which adjoins in time to VOP which should be coded now in VOP decoded in order to have been coded as I-VOP or P-VOP in the past and to use by the coding between screens here. At most two VOP(s) are referred to in the coding between **of 1 time** screens. All MB(s) contained in I-VOP must be coded in Intra. On the other hand, each MB contained in P and B-VOP may be coded using which of intra and an interchange. Here, "VOP is formed into a screen inner code", "intra coding of the VOP being carried out", and all "it codes by I-VOP" show the same contents. Therefore, a contents difference does not have this the expression of any and it means the same contents.
0018 Hereafter, coding processing of MB unit is described briefly. When VOP containing MB which should be coded is I-VOP, the coding part 1 compresses the quantized DCT coefficient by variable length coding about a luminance signal and a color-difference signal. The quantized DCT coefficient is computed by DCT and quantization being performed about a luminance signal and a color-difference signal. And according to the given order, a bit stream is created with header information.
0019 When VOP which contains MB which should be coded on the other hand is except I-VOP, MB on the reference VOP as for which the difference value (MC error) in a luminance signal with MB which the coding part 1 should code becomes the smallest is discovered. The reference VOP is coded VOP which adjoins in time to VOP containing MB which should be coded. MB which becomes the smallest by MB on the reference VOP in the difference value (MC error) in a luminance signal with MB which should be coded is discovered. In order to discover this MB, the motion detection method represented by block matching is used. The vector which shows the motion from MB which should be coded to MB to which MC error becomes the smallest is generated. This vector is called a motion vector. DCT and quantization are performed to MC error. The obtained motion vector and the DCT coefficient quantized about MC error of the luminance signal and the color-difference signal are compressed by variable length coding. The these-compressed motion vector and the quantized DCT coefficient are generated as a bit stream according to the given order with header information.
0020 The control signal which specifies the frame rate of the video outputted from the frame rate updating section 4 is outputted to the coding part 1. The control signal which specifies the desired value of the code amount generated by coding from the generated code amount control section 5 is outputted to the coding part 1. These frame rates and the desired value of a generated code amount are specified, and the coding part 1 performs a frame skip or stuffing. And the code sequence by which variable length coding was carried out is outputted to the output buffer 2.
0021 The output buffer 2 outputs the coding row coded in the coding part 1 by the target bit rate. This bit rate is set up by the device control part 7. The generated code amount of VOP is computed and the computed generated code amount is outputted to the virtual buffer 3 and the generated code amount control section 5.
0022 The initial value (B_0 of drawing 1) of the buffer occupied quantity to which the virtual buffer 3 was set by the device control part 7 is set as buffer occupied quantity. The generated code amount (d0 of drawing 1) of the first frame obtained from the output buffer 2 is decreased from buffer occupied quantity after coding of the first frame (B'_0 of drawing 1). Then, the value which multiplied the time (T of drawing 1: frame interval) to the frame coded next by the bit rate is made to increase to buffer occupied quantity (B_1 of drawing 1). It performs for every frame decreasing after this the generated code amount obtained from the output buffer 2 from buffer occupied quantity, and making the value which multiplied the following frame interval by the bit rate increase to buffer occupied quantity. The virtual buffer 3 gives the buffer occupied quantity for every time to the frame rate updating section 4, the generated code amount control section 5, and the coding mode set part 6.
0023 The frame rate updating section 4 inspects the buffer occupied quantity after the code amount for one sheet was removed, and outputs the frame rate according to the threshold (control point) corresponding to the buffer occupied quantity which performs the frame skip set up beforehand to the coding mode set part 6 and the coding part 1. The frame rate according to two or more control points is outputted to the coding mode set part 6 and the coding part 1.
0024 The generated code amount control section 5 memorizes the generated code amount of coded VOP which is obtained from the output buffer 2, and the average value of the quantizing scale of coded VOP according to coding mode, and gives this to the coding mode set part 6. The VOP coding mode which should be coded next is determined in consideration of a predetermined rule (for example, GOP structure of MPEG-2), or change of video mentioned later, and this is given to the coding mode set part 6. A quantizing scale, the number of stuffing bits, etc. of VOP which should be coded next are given from the buffer occupied quantity of the virtual buffer 3 to the coding part 1.
0025 The coding mode set part 6 presumes the generated code amount at the time of being coded by the coding mode determined by the generated code amount control section 5. The buffer occupied quantity of the virtual buffer 3 after coding is presumed from this code amount and the buffer occupied quantity obtained from the virtual buffer 3. And the control signal which specifies coding mode suitable for the frame rate corresponding to the presumed buffer occupied quantity is outputted to the coding part 1.
0026 The device control part 7 controls the coding part 1, the output buffer 2, the virtual buffer 3, the frame rate updating section 4, and the generated code amount control section 5. For example, the bit stream which a device should output is controlled. Specifically, the generated code amount (object bit rate) used as a target is directed to the generated code amount control section 5. To suit this object bit rate, the generated code amount control section 5 gives various encoding parameters (a quantizing scale, the number of stuffing bits, coding mode, and the number of frame skips) to the coding part 1, and is controlling the generated code amount. The frame number per unit time used as a target (target frame rate) is directed to the frame rate updating section 4. The value of the amount of initial delay is directed to the virtual buffer 3. The setups of coding modes, such as error resistance, are set as the generated code amount control section 5. A control point may be set up. The device control part 7 also performs control of the picture signal inputted into a device.
0027 Drawing 3 is a flow chart which sets up the method to code by presuming the frame rate after coding.
0028 In consideration of improvement in image quality, error tolerance, and random access nature, it may be coded by I-VOP in a bit stream. It is known that the code amount which the direction which codes by I-VOP generally generates rather than coding by P-VOP or B-VOP will increase.
0029 Therefore, if I-VOP is inserted frequently, the virtual buffer 3 will become an underflow tendency. When it codes by I-VOP with comparatively many generated code amounts by the case where buffer occupied quantity is low, especially (for example, when it is B (min) of drawing 1, drawing 4, or drawing 5), it is less than B (min), the number of frame skips increases rapidly, and the case where a target frame rate becomes small rapidly may happen. Thus, when a user looks at the coded video in which the target frame rate is changed rapidly, appearance senses in many cases that it is bad. So, in changing a target frame rate rapidly by insertion of I-VOP, it controls not to code by I-VOP.
0030A start of coding of video will judge whether intra coding of the VOP is carried out by step ST-A1. The generated code amount control section 5 performs this judgment. For example, when video changes dramatically (scene change), it controls carrying out intra coding of the VOP etc. When it judges with the generated code amount control section 5 carrying out intra coding of the VOP, it progresses to step ST-A3. On the other hand, when it judges with the generated code amount control section 5 not carrying out intra coding of the VOP, it progresses to step ST-A2.
0031 Inter encoding of the VOP is carried out in step ST-A2. Here, it codes to P-VOP. It may be set up code not only to P-VOP but to B-VOP. The generated code amount control section 5 may judge, and it may set up code to either P-VOP or B-VOP. It may perform performing about I-VOP in step ST-A3 and ST-A4

so that it may mention later also about P-VOP. That is, the frame rate after coding is presumed by P-VOP, and it may be set up code by B-VOP when this frame rate is beyond a predetermined value.
0032 In step ST-A3, the frame rate after coding to I-VOP is presumed. And in step ST-A4, it is judged whether the difference of the frame rate presumed by step ST-A3 and a desired frame rate is smaller than a predetermined value. That is, it is judged whether the frame rate presumed by step ST-A3 is changing rapidly as compared with the frame rate in front of that. In this case, when that difference is smaller than a predetermined value, it will be judged with the frame rate not changing rapidly. This predetermined value is given by the device control part 7. When the difference of the frame rate presumed by step ST-A4 step ST-A3 and a desired frame rate is smaller than a predetermined value, it progresses to step ST-A5. On the other hand, when the difference of the frame rate presumed by step ST-A3 and a desired frame rate is not smaller than a predetermined value, it progresses to step ST-A2.
0033 In order to presume a frame rate, it is necessary to get to know the buffer occupied quantity of the virtual buffer 3 after coding by I-VOP. That is, the code amount at the time of coding by I-VOP is needed. Then, the coding mode set part 6 guesses the code amount of I-VOP from the code amount and the average value of a quantizing scale of I-VOP coded before. It becomes possible to calculate and guess the buffer occupied quantity of the virtual buffer 3 at the time of coding to I-VOP with the code amount of this guessed I-VOP, and the buffer occupied quantity of the virtual buffer 3 in front of coding. A frame rate can be presumed if buffer occupied quantity is guessed.
0034 Video is coded by I-VOP step ST-A5. And in order to code the next VOP, it returns to step ST-A1. And the above-mentioned step is repeated until it codes all the video.
0035 Drawing 4 is a figure showing an example of the buffer occupied quantity of the virtual buffer 3 to the time in the case where a certain video is coded by the conventional method. Drawing 5 is a figure showing the buffer occupied quantity of the virtual buffer 3 to the time at the time of coding the video coded as shown in drawing 4 using the video coding equipment in a 1st embodiment.
0036 By performing coding according to the flow chart shown in drawing 3, drawing 5 shows the case where P-VOP coding is carried out by time t_I which is carrying out intra coding of the VOP by drawing 4 without carrying out intra coding of the VOP. That is, in time t_I shown in drawing 4 and drawing 5, although it has coded to I-VOP in drawing 4, it has coded to P-VOP by drawing 5.
0037 In drawing 5, as shown in drawing 3, the frame rate after coding to I-VOP is presumed, and when change of the frame rate is less than a predetermined value, it is coded by I-VOP (time t'_I of drawing 5). If I-VOP coding is carried out by time t_I shown in drawing 4, as a frame skip is shown in drawing 4, before and after being coded by I-VOP, it will change sharply. In order to avoid changing a frame rate sharply in drawing 5 by the method shown in drawing 3 if coded by I-VOP before and behind time t_I when coding by time t_I, in time t_I, it codes to P-VOP.
0038 As a result, as shown in drawing 4, change of the number of frame skips which is seen before and behind time t_I is lost, and it becomes possible to obtain a frame skip with little change. Therefore, it becomes possible to realize improvement in image quality through the whole video.
0039(A 2nd embodiment) The composition of the video coding equipment concerning a 2nd embodiment of this invention is the same as the composition of the dynamic image code-ized device concerning a 1st embodiment. That is, the video coding equipment of this invention consists of the coding part 1, the output buffer 2, the virtual buffer 3, the frame rate updating section 4, the generated code amount control section 5, the coding mode set part 6, and the device control part 7. However, operations of the frame rate updating section 4 and the generated code amount control section 5 differ. Hereafter, a 2nd embodiment is described focusing on this point of difference.
0040 Drawing 6 is a figure showing the buffer occupied quantity of the virtual buffer 3 to the time in a 2nd embodiment of this invention, The history (dashed line) of the buffer occupied quantity of the virtual buffer 3 to the time at the time of carrying out three-stage setting out of the threshold (control point) corresponding to the buffer occupied quantity which performs a frame skip (B1, B-2, and B (min) which are shown in drawing 6), It is a figure showing the history (solid line) of the buffer occupied quantity of the virtual buffer 3 to the time at the time of accepting and setting up one control point (B shown in drawing 6 (min)).
0041 In the example shown in the dashed line of drawing 6, the control point which is the above-mentioned threshold is formed three steps. B (min) is set as B1 and the next as B-2 and final full limits as a big value as biggest value. B (min) is a size whose one picture is the grade by which inter encoding was carried out, and the difference of B1 and B-2 and the difference of B-2 and B (min) are also the sizes whose one picture is the grade by which inter encoding was carried out. However, the manufacturer of video coding equipment is able not to limit these values in particular and to set it as a desired value free. The buffer occupied quantity in the virtual buffer 3 is inputted into the frame rate updating section 4, and outputs the target frame rate according to the control point set as the three-stage to the coding mode set part 6 and the coding part 1.
0042 Let target frame rates be 15 seconds. That is, in the usual control, the number of sheets which the frame interval to code skips the two whole sheets performs coding by setting out of one sheet. The conditions that skip number of sheets when skip number of sheets when the skip number of sheets in normal operation is less than 1 and B1 in the frame rate updating section 4 is less than 2 and B-2 skips only skip number of sheets until a buffer is recovered when less than 3 and B (min) are inputted.
0043 When buffer occupied quantity comes out enough and it does not set up a control point in the state of the beginning shown in drawing 6 (time is from 0 to t_3) for a certain reason (history of a solid line), the case (history of a dashed line) where a control point is set up shows the history of the same buffer occupied quantity. The time interval T fixed from t_0 to t_3 is maintained. This time interval (frame skip) is in inverse proportion to a frame rate. Therefore, from t_0 to t_3 of drawing 6, a frame rate saves 15 seconds, and it is coded, skipping one sheet. In time t_3, it is less than the 1st control point B1. Therefore, in the frame rate updating section 4, the skip number of sheets 2 corresponding to B1 is chosen. Then, the number of frame skips increases. A frame rate will become late if it puts in another way. In drawing 6, if time coded next is made into t'_4, it will be set to t'_4-t_3>T. In subsequent t'_4 and t'_5, t'_6, skip number of sheets continues with 3, 2, and 3, respectively. Thus, in the example of coding shown in drawing 6, when three control points are set up, the number of frame skips is not more than three sheets. An opportunity for it to be less than B (min) through the whole decreases remarkably, and stops therefore, needing a big frame skip.
0044 On the other hand, when the control point B1 and B-2 are not set up, in time t_3, skip number of sheets is still 1. And in time t_4 coded next, it is less than B (min) in this case. Therefore, in order to prevent buffer underflow, a big frame skip is performed. In the case of drawing 6, it will increase as for skip number of sheets more than three sheets. Since the skip number of sheets more than B (min) is always 1, if there is a frame with many code amounts, the case where buffer occupied quantity is less than B (min) again may occur frequently like **in the case of being time t_6** . As a result, the number of frame skips swings between 1 and 3, and change of the number of frame skips becomes large. If it is in this case, even when going back and forth between the circumference of the control point of B1, the change of the number of frame skips does not need to impress a big change in appearance in order to end by one sheet.
0045 As mentioned above, when there are two or more control points, as compared with the case where there is only one control point, the size of fluctuation of the number of frame skips is small. Therefore, it is not necessary to impress a big change in appearance. since it is set up so that the number of frame skips of buffer occupied quantity may change one sheet at a time gradually, as compared with the case where there is only one control point, a possibility that the two numbers of frame skips will change suddenly is boiled markedly, and decreases. Since buffer occupied quantity furthermore changes with a high value through the whole, making a quantization scale value coarse also decreases, and improvement in image quality through the whole can be realized.
0046 Drawing 7 is a flow chart including the process of setting up the method coded by checking the number of VOP(s) within the past predetermined time by which intra coding was carried out in addition to the process of drawing 3.
0047 That by which one step was added to the flow which shows operation of the coding by a 1st embodiment is a flow which shows operation of the coding by a 2nd embodiment. That is, a new step is added between step ST-A1 of drawing 3, and step ST-A3. A new step is for making it not frequently coded by I-VOP.
0048 As mentioned above, the code amount which the direction which codes by I-VOP generates rather than coding by P-VOP or B-VOP generally increases. Therefore, if I-VOP is inserted frequently, the virtual buffer 3 will become an underflow tendency. For example, when video is a scene change which changes dramatically, intra coding of the VOP is carried out in many cases, and when a scene change occurs frequently, the virtual buffer 3 becomes an underflow tendency easily. Then, it controls not to insert I-VOP frequently. By a 2nd embodiment, the maximum VOP number coded by I-VOP among VOP(s) coded within a certain fixed time is restricted as the method.
0049 When it is specifically determined that the generated code amount control section 5 will carry out intra coding of the VOP, it progresses to step ST-B3 from step ST-B1. Step ST-B3 compares the VOP number coded by I-VOP in the past predetermined time with the predetermined number set up beforehand. When the VOP number coded by I-VOP is more than a predetermined number, it is considered that buffer occupied quantity is in the state which buffer underflow tends to generate small. In this case, it does not code to I-VOP but codes by P-VOP (ST-B2). The set-up predetermined number is usually determined depending on the size of the virtual buffer 3. The coding mode set part 6 counts the I-VOP number within the past predetermined time, for example, and it is set up so that it may be updated, whenever VOP is coded.
0050 As a result, it can control that I-VOP is frequently inserted by step ST-B3 and the virtual buffer 3 becomes a buffer underflow tendency by it.
0051 All other steps are the same as that of drawing 3 shown by a 1st embodiment.

0052 Drawing 8 is a figure showing the buffer occupied quantity of the virtual buffer 3 to the time at the time of setting up the threshold shown in drawing 6, using the method shown in the flow chart of drawing 7, and coding video.
0053 When buffer occupied quantity is below in B1 or B-2s, such as time t_1, t_2, and t_3, as for more than B-2, according to less than B-2 and less than B (min), the number of frame skips is increased **less than / B1 / and more than B (min)** gradually. As a result, in the frame of next doors, the number of sheets to skip only has a difference of a maximum of one sheet. By the way, when buffer occupied quantity is less than B (min), the number-of-sheets difference skipped between the next frames may be one or more sheets. However, since the number of frame skips is gradually increased by the threshold B1 and B-2 more than B (min), it is few when a skip number-of-sheets difference will be two or more sheets. Therefore, it enables a user to see the smoothly stable video, without changing a picture sharply for appearance. Since buffer occupied quantity changes with a high value through the whole, making a quantization scale value coarse also decreases, and improvement in image quality through the whole can be realized.
0054 The maximum VOP number coded by I-VOP regardless of buffer occupied quantity among VOP(s) coded within a certain fixed time is restricted. When coding a certain VOP, it presumes how a frame rate changes and it is determined according to the presumed frame rate whether to carry out intra coding or carry out inter encoding. Therefore, it is avoidable that a frame rate falls rapidly. Therefore, it becomes possible to prevent buffer underflow. It can also be prevented the number of frame skips increasing suddenly. As a result, it enables a user to see the smoothly stable video, without changing a picture sharply for appearance. Since buffer occupied quantity changes with a high value through the whole, making a quantization scale value coarse also decreases, and improvement in image quality through the whole can be realized.
0055 This invention is not limited to the embodiment mentioned above, in that technical scope, can change variously and can be carried out.
0056
Effect of the Invention It becomes possible to see the smoothly stable video, without changing a picture sharply for appearance, since it is avoidable to change the number of frame skips sharply according to the video coding equipment of this invention.
0057 It becomes possible for buffer occupied quantity to make it change with a high value through the whole. Therefore, making a quantization scale value coarse also decreases and improvement in image quality through the whole can be realized.

Field of the Invention This invention relates to the video coding equipment for elongating the video compressed especially about the video coding equipment for compressing video or elongating the compressed video, and outputting a clear picture.

Description of the Prior Art With the video coding equipment in this invention. ITU-T (International.) H.26x and ISO/IEC (International Standards Organization/International.) of Telecommunication Union-Telecommunication sector advice It is a device for coding video with the video coding mode represented by standard MPEG (Moving Picture Experts Group) for Electrotechnical Commission. That is, video coding equipment performs coding per frame using a motion compensation, orthogonal transformation (for example, discrete cosine transform), etc.
0003 Generally, to the video signal inputted, the video coding mode represented by MPEG H.26x of an ITU-T recommendation and standard for ISO/IEC is spatial, and applies compression with temporal correlation. Based on the data obtained by this compression, according to the given order, variable length coding is performed further, and a code sequence (bit stream) is generated.
0004 Video coding equipment must output the bit stream of the code amount specified according to the predetermined encoding parameter. Furthermore, in the buffer by the side of a decoder, a generated code amount must be controlled by the encoder side supposing the occupation of the buffer by the side of a decoder so that neither overflow nor underflow arises. This buffer is called a VBV (Video Buffering Verifier) buffer. It may only be called a virtual buffer. As for the capacity of the VBV buffer, upper limit was decided by MPEG-4 with the profile and the level. A generated code amount is controlled by the quantizing scale used in order to quantize the discrete cosine transform (DCT:Discrete Cosine Transform) coefficient obtained as a result of DCT's being performed by every macro block (MB:MacroBlock) in a frame. Generally, a generated code amount and a quantizing scale have a relation of reverse proportion. It is possible to change a generated code amount free using this character.
0005 However, since a quantizing scale generally has restriction, it is impossible to control a generated code amount only by a quantizing scale. Then, when there are more generated code amounts than a desired value, the number of frame skips is increased. By increasing the number of frame skips, the frame which should be coded can be delayed and the underflow of a VBV buffer can be prevented. Stuffing is performed when there are few generated code amounts than a desired value. Stuffing is inserting a redundant bit and prevents overflow of a VBV buffer.
0006 Drawing 1 is a figure showing the conventional method of controlling a virtual buffer, and shows the buffer occupied quantity of the virtual buffer to time. As the control method of a frame skip, the boundary value (B (min)) in a VBV buffer is established. The amount of buffers is made to increase by skipping until it increases the number of frame skips when less than this (time t_4 shown in drawing 1), and it exceeds a boundary value.

Effect of the Invention It becomes possible to see the smoothly stable video, without changing a picture sharply for appearance, since it is avoidable to change the number of frame skips sharply according to the video coding equipment of this invention.
0057 It becomes possible for buffer occupied quantity to make it change with a high value through the whole. Therefore, making a quantization scale value coarse also decreases and improvement in image quality through the whole can be realized.

Problem(s) to be Solved by the Invention However, according to this method, when a state with many generated code amounts continues, a state with little buffer occupied quantity continues, and buffer occupied quantity moves the boundary-value circumference up and down. For example, it moves up and down like time t_4 shown in drawing 1, and time t_5. Therefore, the operation which increases the number of frame skips and recovers a buffer, and operation of a predetermined frame skip are repeated. As a result, it will be in a state with an unstable frame interval, and quality will worsen dramatically also at appearance.
0008 In consideration of improvement in image quality, error tolerance, and random access nature, I-VOP (I-VOP:Intra-Video Object Plane) may be inserted into a bit stream. Since I-VOP has comparatively many code amounts, a VBV buffer will become an underflow tendency if I-VOP is inserted frequently. There is a problem that the number of frame skips increases rapidly, by inserting I-VOP around said boundary value.
0009 Then, the video where the purpose of this invention raised the quality of the appearance of video and which was stabilized smoothly being reproduced in view of the problem in these former is providing the video coding equipment which becomes possible.

Means for Solving the Problem In video coding equipment which according to this invention performs coding while referring to a virtual buffer for guessing an occupation of a buffer by the side of decoding, A generated code amount estimation means which presumes a generated code amount when one picture is formed into a screen inner code, A buffer-occupied-quantity estimation means which presumes buffer occupied quantity of said virtual buffer when a generated code amount presumed for said one picture is removed, A frame rate estimation means which is based in said presumed buffer occupied quantity, and presumes a frame rate, A frame rate setting means which specifies a desired frame rate, and said presumed frame rate, A frame rate judging means which judges whether a difference with said frame rate specified is beyond a predetermined value, An encoding control means to control to perform screen inner code-ization when a difference of said judged frame rate is less than a predetermined value, and to perform coding by the coding between screens when a difference of said judged frame rate is beyond a predetermined value, It is provided by providing video coding equipment.
0011 This video coding equipment predicts a virtual buffer after I-VOP coding, and when changing sharply a frame rate obtained from that predicted value from the present frame rate, it does not code I-VOP.
0012 Two or more control points are formed in a virtual buffer, and a frame rate updating section which sets up a different frame rate for every point of the is provided. This frame rate set up every two or more points is sent to a coding part of video, and a coding part codes by skipping a picture inputted according to a specified frame rate.
0013 The number of I-VOP which should be contained within predetermined time from buffer occupied quantity of a virtual buffer is controlled, and buffer underflow is controlled.

0014
Embodiment of the Invention Hereafter, with reference to Drawings, the embodiment of the video coding equipment of this invention is described.
(A 1st embodiment) Drawing 2 is a functional block diagram showing the electric internal configuration of the video coding equipment in a 1st embodiment. The video coding equipment of this invention consists of the coding part 1, the output buffer 2, the virtual buffer 3, the frame rate updating section 4, the generated code amount control section 5, the coding mode set part 6, and the device control part 7.
0015 The coding part 1 inputs the picture signal which should be coded from a picture input device. A picture input device is a signal source of a dynamic image signal like a digital video camera or recording playback apparatus. The inputted picture signal is coded according to predetermined video compression technology, i.e., MPEG-4 standard method for ISO/IEC and H.263 method of an ITU-T recommendation, or the method which changed these. Coding divides each frame contained in the inputted picture signal into a predetermined macro block according to video compression technology. From the coding mode set part 6, the coding mode (intra coding or inter encoding) which codes each macro block is inputted.
0016 Below, the video coding mode in MPEG-4 (Moving Picture Experts Group Phase 4) is described. A video signal comprises two or more video object plains (VOP:Video Object Plane). In the case of rectangular shape, VOP is equivalent to the frame and the field in MPEG-1 and 2. Spatial per VOP and it compresses with temporal correlation. VOP has a luminance signal and a color-difference signal, and comprises two or more MB(s). MB consists of 16 pixels of every direction to a luminance signal. Spatial compression and time compression are performed by this MB unit. A picture is compressed by DCT and quantization in spatial compression. A picture is compressed by the motion compensation (MC:Motion Compensation) in time compression.
0017 The compression method of a VOP unit has the formation of a screen inner code (intra coding) coded only by spatial compression, and the coding between screens (formation of interchange agreement) coded by spatial compression and time compression. VOP formed into the screen inner code is called I-VOP (Intra-VOP). VOP coded between screens has two kinds such as P-VOP (Predictive-VOP) and B-VOP (Bi-directionally predictive-VOP). Only VOP before coded in time as the reference VOP is VOP referred to, and P-VOP is VOP which MC of the uni directional was performed and was coded. VOP coded forward and backward in time as the reference VOP is VOP referred to, and B-VOP is VOP which bidirectional MC was performed and was coded. In the reference VOP, it is VOP which adjoins in time to VOP which should be coded now in VOP decoded in order to have been coded as I-VOP or P-VOP in the past and to use by the coding between screens here. At most two VOP(s) are referred to in the coding between **of 1 time** screens. All MB(s) contained in I-VOP must be coded in Intra. On the other hand, each MB contained in P and B-VOP may be coded using which of intra and an interchange. Here, "VOP is formed into a screen inner code", "intra coding of the VOP being carried out", and all "it codes by I-VOP" show the same contents. Therefore, a contents difference does not have this the expression of any and it means the same contents.
0018 Hereafter, coding processing of MB unit is described briefly. When VOP containing MB which should be coded is I-VOP, the coding part 1 compresses the quantized DCT coefficient by variable length coding about a luminance signal and a color-difference signal. The quantized DCT coefficient is computed by DCT and quantization being performed about a luminance signal and a color-difference signal. And according to the given order, a bit stream is created with header information.
0019 When VOP which contains MB which should be coded on the other hand is except I-VOP, MB on the reference VOP as for which the difference value (MC error) in a luminance signal with MB which the coding part 1 should code becomes the smallest is discovered. The reference VOP is coded VOP which adjoins in time to VOP containing MB which should be coded. MB which becomes the smallest by MB on the reference VOP in the difference value (MC error) in a luminance signal with MB which should be coded is discovered. In order to discover this MB, the motion detection method represented by block matching is used. The vector which shows the motion from MB which should be coded to MB to which MC error becomes the smallest is generated. This vector is called a motion vector. DCT and quantization are performed to MC error. The obtained motion vector and the DCT coefficient quantized about MC error of the luminance signal and the color-difference signal are compressed by variable length coding. The these-compressed motion vector and the quantized DCT coefficient are generated as a bit stream according to the given order with header information.
0020 The control signal which specifies the frame rate of the video outputted from the frame rate updating section 4 is outputted to the coding part 1. The control signal which specifies the desired value of the code amount generated by coding from the generated code amount control section 5 is outputted to the coding part 1. These frame rates and the desired value of a generated code amount are specified, and the coding part 1 performs a frame skip or stuffing. And the code sequence by which variable length coding was carried out is outputted to the output buffer 2.
0021 The output buffer 2 outputs the coding row coded in the coding part 1 by the target bit rate. This bit rate is set up by the device control part 7. The generated code amount of VOP is computed and the computed generated code amount is outputted to the virtual buffer 3 and the generated code amount control section 5.
0022 The initial value (B_0 of drawing 1) of the buffer occupied quantity to which the virtual buffer 3 was set by the device control part 7 is set as buffer occupied quantity. The generated code amount (d0 of drawing 1) of the first frame obtained from the output buffer 2 is decreased from buffer occupied quantity after coding of the first frame (B'_0 of drawing 1). Then, the value which multiplied the time (T of drawing 1: frame interval) to the frame coded next by the bit rate is made to increase to buffer occupied quantity (B_1 of drawing 1). It performs for every frame decreasing after this the generated code amount obtained from the output buffer 2 from buffer occupied quantity, and making the value which multiplied the following frame interval by the bit rate increase to buffer occupied quantity. The virtual buffer 3 gives the buffer occupied quantity for every time to the frame rate updating section 4, the generated code amount control section 5, and the coding mode set part 6.
0023 The frame rate updating section 4 inspects the buffer occupied quantity after the code amount for one sheet was removed, and outputs the frame rate according to the threshold (control point) corresponding to the buffer occupied quantity which performs the frame skip set up beforehand to the coding mode set part 6 and the coding part 1. The frame rate according to two or more control points is outputted to the coding mode set part 6 and the coding part 1.
0024 The generated code amount control section 5 memorizes the generated code amount of coded VOP which is obtained from the output buffer 2, and the average value of the quantizing scale of coded VOP according to coding mode, and gives this to the coding mode set part 6. The VOP coding mode which should be coded next is determined in consideration of a predetermined rule (for example, GOP structure of MPEG-2), or change of video mentioned later, and this is given to the coding mode set part 6. A quantizing scale, the number of stuffing bits, etc. of VOP which should be coded next are given from the buffer occupied quantity of the virtual buffer 3 to the coding part 1.
0025 The coding mode set part 6 presumes the generated code amount at the time of being coded by the coding mode determined by the generated code amount control section 5. The buffer occupied quantity of the virtual buffer 3 after coding is presumed from this code amount and the buffer occupied quantity obtained from the virtual buffer 3. And the control signal which specifies coding mode suitable for the frame rate corresponding to the presumed buffer occupied quantity is outputted to the coding part 1.
0026 The device control part 7 controls the coding part 1, the output buffer 2, the virtual buffer 3, the frame rate updating section 4, and the generated code amount control section 5. For example, the bit stream which a device should output is controlled. Specifically, the generated code amount (object bit rate) used as a target is directed to the generated code amount control section 5. To suit this object bit rate, the generated code amount control section 5 gives various encoding parameters (a quantizing scale, the number of stuffing bits, coding mode, and the number of frame skips) to the coding part 1, and is controlling the generated code amount. The frame number per unit time used as a target (target frame rate) is directed to the frame rate updating section 4. The value of the amount of initial delay is directed to the virtual buffer 3. The setups of coding modes, such as error resistance, are set as the generated code amount control section 5. A control point may be set up. The device control part 7 also performs control of the picture signal inputted into a device.
0027 Drawing 3 is a flow chart which sets up the method to code by presuming the frame rate after coding.
0028 In consideration of improvement in image quality, error tolerance, and random access nature, it may be coded by I-VOP in a bit stream. It is known that the code amount which the direction which codes by I-VOP generally generates rather than coding by P-VOP or B-VOP will increase.
0029 Therefore, if I-VOP is inserted frequently, the virtual buffer 3 will become an underflow tendency. When it codes by I-VOP with comparatively many generated code amounts by the case where buffer occupied quantity is low, especially (for example, when it is B (min) of drawing 1, drawing 4, or drawing 5), it is less than B (min), the number of frame skips increases rapidly, and the case where a target frame rate becomes small rapidly may happen. Thus, when a user looks at the coded video in which the target frame rate is changed rapidly, appearance senses in many cases that it is bad. So, in changing a target frame rate rapidly by insertion of I-VOP, it controls not to code by I-VOP.
0030A start of coding of video will judge whether intra coding of the VOP is carried out by step ST-A1. The generated code amount control section 5 performs this judgment. For example, when video changes dramatically (scene change), it controls carrying out intra coding of the VOP etc. When it judges with the generated code amount control section 5 carrying out intra coding of the VOP, it progresses to step ST-A3. On the other hand, when it judges with the generated code amount control section 5 not carrying out intra coding of the VOP, it progresses to step ST-A2.
0031 Inter encoding of the VOP is carried out in step ST-A2. Here, it codes to P-VOP. It may be set up code not only to P-VOP but to B-VOP. The generated code amount control section 5 may judge, and it may set up code to either P-VOP or B-VOP. It may perform performing about I-VOP in step ST-A3 and ST-A4 so that it may mention later also about P-VOP. That is, the frame rate after coding is presumed by P-VOP, and it may be set up code by B-VOP when this frame rate is beyond a predetermined value.
0032 In step ST-A3, the frame rate after coding to I-VOP is presumed. And in step ST-A4, it is judged whether the difference of the frame rate presumed by step ST-A3 and a desired frame rate is smaller than a predetermined value. That is, it is judged whether the frame rate presumed by step ST-A3 is changing

rapidly as compared with the frame rate in front of that. In this case, when that difference is smaller than a predetermined value, it will be judged with the frame rate not changing rapidly. This predetermined value is given by the device control part 7. When the difference of the frame rate presumed by step ST-A4 step ST-A3 and a desired frame rate is smaller than a predetermined value, it progresses to step ST-A5. On the other hand, when the difference of the frame rate presumed by step ST-A3 and a desired frame rate is not smaller than a predetermined value, it progresses to step ST-A2.

0033 In order to presume a frame rate, it is necessary to get to know the buffer occupied quantity of the virtual buffer 3 after coding by I-VOP. That is, the code amount at the time of coding by I-VOP is needed. Then, the coding mode set part 6 guesses the code amount of I-VOP from the code amount and the average value of a quantizing scale of I-VOP coded before. It becomes possible to calculate and guess the buffer occupied quantity of the virtual buffer 3 at the time of coding to I-VOP with the code amount of this guessed I-VOP, and the buffer occupied quantity of the virtual buffer 3 in front of coding. A frame rate can be presumed if buffer occupied quantity is guessed.

0034 Video is coded by I-VOP step ST-A5. And in order to code the next VOP, it returns to step ST-A1. And the above-mentioned step is repeated until it codes all the video.

0035 Drawing 4 is a figure showing an example of the buffer occupied quantity of the virtual buffer 3 to the time in the case where a certain video is coded by the conventional method. Drawing 5 is a figure showing the buffer occupied quantity of the virtual buffer 3 to the time at the time of coding the video coded as shown in drawing 4 using the video coding equipment in a 1st embodiment.

0036 By performing coding according to the flow chart shown in drawing 3, drawing 5 shows the case where P-VOP coding is carried out by time t_I which is carrying out intra coding of the VOP by drawing 4 without carrying out intra coding of the VOP. That is, in time t_I shown in drawing 4 and drawing 5, although it has coded to I-VOP in drawing 4, it has coded to P-VOP by drawing 5.

0037 In drawing 5, as shown in drawing 3, the frame rate after coding to I-VOP is presumed, and when change of the frame rate is less than a predetermined value, it is coded by I-VOP (time t'_I of drawing 5). If I-VOP coding is carried out by time t_I shown in drawing 4, as a frame skip is shown in drawing 4, before and after being coded by I-VOP, it will change sharply. In order to avoid changing a frame rate sharply in drawing 5 by the method shown in drawing 3 if coded by I-VOP before and behind time t_I when coding by time t_I, in time t_I, it codes to P-VOP.

0038 As a result, as shown in drawing 4, change of the number of frame skips which is seen before and behind time t_I is lost, and it becomes possible to obtain a frame skip with little change. Therefore, it becomes possible to realize improvement in image quality through the whole video.

0039(A 2nd embodiment) The composition of the video coding equipment concerning a 2nd embodiment of this invention is the same as the composition of the dynamic image code-ized device concerning a 1st embodiment. That is, the video coding equipment of this invention consists of the coding part 1, the output buffer 2, the virtual buffer 3, the frame rate updating section 4, the generated code amount control section 5, the coding mode set part 6, and the device control part 7. However, operations of the frame rate updating section 4 and the generated code amount control section 5 differ. Hereafter, a 2nd embodiment is described focusing on this point of difference.

0040 Drawing 6 is a figure showing the buffer occupied quantity of the virtual buffer 3 to the time in a 2nd embodiment of this invention, The history (dashed line) of the buffer occupied quantity of the virtual buffer 3 to the time at the time of carrying out three-stage setting out of the threshold (control point) corresponding to the buffer occupied quantity which performs a frame skip (B1, B-2, and B (min) which are shown in drawing 6), It is a figure showing the history (solid line) of the buffer occupied quantity of the virtual buffer 3 to the time at the time of accepting and setting up one control point (B shown in drawing 6 (min)).

0041 In the example shown in the dashed line of drawing 6, the control point which is the above-mentioned threshold is formed three steps. B (min) is set as B1 and the next as B-2 and final full limits as a big value as biggest value. B (min) is a size whose one picture is the grade by which inter encoding was carried out, and the difference of B1 and B-2 and the difference of B-2 and B (min) are also the sizes whose one picture is the grade by which inter encoding was carried out. However, the manufacturer of video coding equipment is able not to limit these values in particular and to set it as a desired value free. The buffer occupied quantity in the virtual buffer 3 is inputted into the frame rate updating section 4, and outputs the target frame rate according to the control point set as the three-stage to the coding mode set part 6 and the coding part 1.

0042 Let target frame rates be 15 seconds. That is, in the usual control, the number of sheets which the frame interval to code skips the two whole sheets performs coding by setting out of one sheet. The conditions that skip number of sheets when skip number of sheets when the skip number of sheets in normal operation is less than 1 and B1 in the frame rate updating section 4 is less than 2 and B-2 skips only skip number of sheets until a buffer is recovered when less than 3 and B (min) are inputted.

0043 When buffer occupied quantity comes out enough and it does not set up a control point in the state of the beginning shown in drawing 6 (time is from 0 to t_3) for a certain reason (history of a solid line), the case (history of a dashed line) where a control point is set up shows the history of the same buffer occupied quantity. The time interval T fixed from t_0 to t_3 is maintained. This time interval (frame skip) is in inverse proportion to a frame rate. Therefore, from t_0 to t_3 of drawing 6, a frame rate saves 15 seconds, and it is coded, skipping one sheet. In time t_3, it is less than the 1st control point B1. Therefore, in the frame rate updating section 4, the skip number of sheets 2 corresponding to B1 is chosen. Then, the number of frame skips increases. A frame rate will become late if it puts in another way. In drawing 6, if time coded next is made into t'_4, it will be set to $t'_4-t_3>T$. In subsequent t'_4 and t'_5, t'_6, skip number of sheets continues with 3, 2, and 3, respectively. Thus, in the example of coding shown in drawing 6, when three control points are set up, the number of frame skips is not more than three sheets. An opportunity for it to be less than B (min) through the whole decreases remarkably, and stops therefore, needing a big frame skip.

0044 On the other hand, when the control point B1 and B-2 are not set up, in time t_3, skip number of sheets is still 1. And in time t_4 coded next, it is less than B (min) in this case. Therefore, in order to prevent buffer underflow, a big frame skip is performed. In the case of drawing 6, it will increase as for skip number of sheets more than three sheets. Since the skip number of sheets more than B (min) is always 1, if there is a frame with many code amounts, the case where buffer occupied quantity is less than B (min) again may occur frequently like **in the case of being time t_6** . As a result, the number of frame skips swings between 1 and 3, and change of the number of frame skips becomes large. If it is in this case, even when going back and forth between the circumference of the control point of B1, the change of the number of frame skips does not need to impress a big change in appearance in order to end by one sheet.

0045 As mentioned above, when there are two or more control points, as compared with the case where there is only one control point, the size of fluctuation of the number of frame skips is small. Therefore, it is not necessary to impress a big change in appearance. since it is set up so that the number of frame skips of buffer occupied quantity may change one sheet at a time gradually, as compared with the case where there is only one control point, a possibility that the two numbers of frame skips will change suddenly is boiled markedly, and decreases. Since buffer occupied quantity furthermore changes with a high value through the whole, making a quantization scale value coarse also decreases, and improvement in image quality through the whole can be realized.

0046 Drawing 7 is a flow chart including the process of setting up the method coded by checking the number of VOP(s) within the past predetermined time by which intra coding was carried out in addition to the process of drawing 3.

0047 That by which one step was added to the flow which shows operation of the coding by a 1st embodiment is a flow which shows operation of the coding by a 2nd embodiment. That is, a new step is added between step ST-A1 of drawing 3, and step ST-A3. A new step is for making it not frequently coded by I-VOP.

0048 As mentioned above, the code amount which the direction which codes by I-VOP generates rather than coding by P-VOP or B-VOP generally increases. Therefore, if I-VOP is inserted frequently, the virtual buffer 3 will become an underflow tendency. For example, when video is a scene change which changes dramatically, intra coding of the VOP is carried out in many cases, and when a scene change occurs frequently, the virtual buffer 3 becomes an underflow tendency easily. Then, it controls not to insert I-VOP frequently. By a 2nd embodiment, the maximum VOP number coded by I-VOP among VOP(s) coded within a certain fixed time is restricted as the method.

0049 When it is specifically determined that the generated code amount control section 5 will carry out intra coding of the VOP, it progresses to step ST-B3 from step ST-B1. Step ST-B3 compares the VOP number coded by I-VOP in the past predetermined time with the predetermined number set up beforehand. When the VOP number coded by I-VOP is more than a predetermined number, it is considered that buffer occupied quantity is in the state which buffer underflow tends to generate small. In this case, it does not code to I-VOP but codes by P-VOP (ST-B2). The set-up predetermined number is usually determined depending on the size of the virtual buffer 3. The coding mode set part 6 counts the I-VOP number within the past predetermined time, for example, and it is set up so that it may be updated, whenever VOP is coded.

0050 As a result, it can control that I-VOP is frequently inserted by step ST-B3 and the virtual buffer 3 becomes a buffer underflow tendency by it.

0051 All other steps are the same as that of drawing 3 shown by a 1st embodiment.

0052 Drawing 8 is a figure showing the buffer occupied quantity of the virtual buffer 3 to the time at the time of setting up the threshold shown in drawing 6, using the method shown in the flow chart of drawing 7, and coding video.

0053 When buffer occupied quantity is below in B1 or B-2s, such as time t_1, t_2, and t_3, as for more than B-2, according to less than B-2 and less than B (min), the number of frame skips is increased **less than / B1 / and more than B (min)** gradually. As a result, in the frame of next doors, the number of

sheets to skip only has a difference of a maximum of one sheet. By the way, when buffer occupied quantity is less than B (min), the number-of-sheets difference skipped between the next frames may be one or more sheets. However, since the number of frame skips is gradually increased by the threshold B1 and B-2 more than B (min), it is few when a skip number-of-sheets difference will be two or more sheets. Therefore, it enables a user to see the smoothly stable video, without changing a picture sharply for appearance. Since buffer occupied quantity changes with a high value through the whole, making a quantization scale value coarse also decreases, and improvement in image quality through the whole can be realized.

0054 The maximum VOP number coded by I-VOP regardless of buffer occupied quantity among VOP(s) coded within a certain fixed time is restricted. When coding a certain VOP, it presumes how a frame rate changes and it is determined according to the presumed frame rate whether to carry out intra coding or carry out inter encoding. Therefore, it is avoidable that a frame rate falls rapidly. Therefore, it becomes possible to prevent buffer underflow. It can also be prevented the number of frame skips increasing suddenly. As a result, it enables a user to see the smoothly stable video, without changing a picture sharply for appearance. Since buffer occupied quantity changes with a high value through the whole, making a quantization scale value coarse also decreases, and improvement in image quality through the whole can be realized.

0055 This invention is not limited to the embodiment mentioned above, in that technical scope, can change variously and can be carried out.

Brief Description of the Drawings

Drawing 1 It is a figure showing the conventional method of controlling a virtual buffer, and is a figure showing the buffer occupied quantity of the virtual buffer to time.

Drawing 2 It is a functional block diagram showing the electric internal configuration of the video coding equipment in the embodiment of this invention.

Drawing 3 It is a flow chart showing the procedure for setting up the method in a 1st embodiment of this invention to code, and is a flow chart which sets up the method to code by presuming the frame rate after coding.

Drawing 4 It is a figure showing an example of the buffer occupied quantity of the virtual buffer to the time in the case where a certain video is coded by the conventional method.

Drawing 5 It is a figure showing the buffer occupied quantity of the virtual buffer to the time at the time of coding the video coded as shown in drawing 4 using the video coding equipment in a 1st embodiment of this invention.

Drawing 6 It is a figure showing the buffer occupied quantity of the virtual buffer to the time in a 2nd embodiment of this invention, The history (dashed line) of the buffer occupied quantity of the virtual buffer to the time at the time of carrying out three-stage setting out of the threshold (control point) corresponding to the buffer occupied quantity which performs a frame skip, It is a figure showing the history (solid line) of the buffer occupied quantity of the virtual buffer to the time at the time of accepting and setting up one control point.

Drawing 7 It is a flow chart showing the procedure for setting up the method in a 2nd embodiment of this invention to code, and is a flow chart including the process of setting up the method coded by checking the number of VOP(s) within the past predetermined time by which intra coding was carried out in addition to the process of drawing 3.

Drawing 8 It is a figure showing the buffer occupied quantity of the virtual buffer to the time at the time of setting up the threshold shown in drawing 6, using the method shown in the flow chart of drawing 7, and coding video.

Description of Notations

1 Coding part
2 Output buffer
3 Virtual buffer
4 Frame rate updating section
5 Generated code amount control section
6 Coding mode set part
7 Device control part

Drawing 1

For drawings please refer to the original document.

Drawing 2

For drawings please refer to the original document.

Drawing 4

For drawings please refer to the original document.

Drawing 5

For drawings please refer to the original document.

Drawing 3

For drawings please refer to the original document.

Drawing 6

For drawings please refer to the original document.

Drawing 7

For drawings please refer to the original document.

Drawing 8

For drawings please refer to the original document.

For drawings please refer to the original document.

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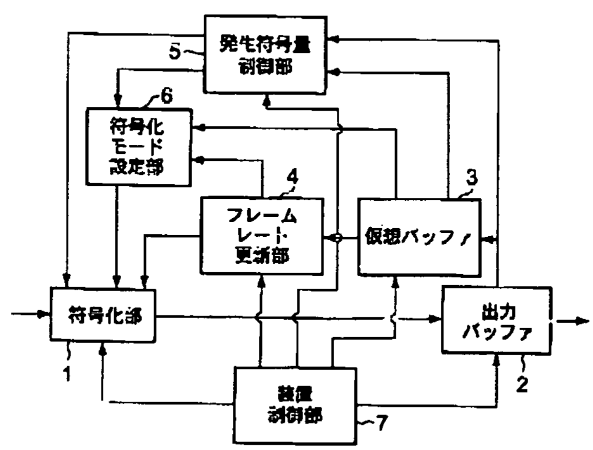
(54)【発明の名称】　動画像符号化装置

(57)【要約】
【課題】　動画像の見た目の品質を向上させ、スムーズに安定した動画像が再生されることが可能になる動画像符号化装置を提供することを目的とする。
【解決手段】　符号化モード設定部6が、1画像が画面内符号化されたときの発生符号量を推定する。また、この発生符号量が取り去られたときの仮想バッファのバッファ占有量も推定する。符号化モード設定部6が、この推定されたバッファ占有量をもとづいて、フレームレートを推定する。装置制御部7が、所望のフレームレートを指定する。推定されたフレームレートと、前記指定されているフレームレートとの差が所定値以上か否かが判定される。判定されたフレームレートの差が所定値未満の場合は画面内符号化を実行し、前記判定されたフレームレートの差が所定値以上である場合は画面間符号化によって符号化を実行するように制御する動画像符号化装置による。



【特許請求の範囲】

【請求項１】　復号側でのバッファの占有量を推測するための仮想バッファを参照しながら符号化を実行する動画像符号化装置において、
１画像が画面内符号化されたときの発生符号量を推定する発生符号量推定手段と、
前記１画像分の推定された発生符号量が取り去られたときの前記仮想バッファのバッファ占有量を推定するバッファ占有量推定手段と、
前記推定されたバッファ占有量をもとづいて、フレームレートを推定するフレームレート推定手段と、
所望のフレームレートを指定するフレームレート指定手段と、
前記推定されたフレームレートと、前記指定されているフレームレートとの差が所定値以上か否かを判定するフレームレート判定手段と、
前記判定されたフレームレートの差が所定値未満の場合は画面内符号化を実行し、前記判定されたフレームレートの差が所定値以上である場合は画面間符号化によって符号化を実行するように制御する符号化制御手段と、
を具備することを特徴とする動画像符号化装置。

【請求項２】　仮想バッファにしきい値を設定する設定手段と、
当該しきい値と１画像が符号化された直後の前記仮想バッファのバッファ占有量とが比較されることによって、フレームレートを更新するフレームレート更新手段と、
をさらに具備することを特徴とする請求項１記載の動画像符号化装置。

【請求項３】　前記設定手段は、バッファ占有量に複数のしきい値を設定することを特徴とする請求項２記載の動画像符号化装置。

【請求項４】　前記フレームレート更新手段は、前記複数のしきい値のうち、最も大きい値を有するしきい値から最も低い値を有するしきい値によって区切られた複数の領域で、１画像が符号化された直後の前記仮想バッファのバッファ占有量が低い領域に属するほど、フレームレートが順に低くなるように更新することを特徴とする請求項３記載の動画像符号化装置。

【請求項５】　過去のある時間内に画面内符号化されたフレームの数を算出するフレーム数算出手段と、
前記算出されたフレーム数が所定数未満か否かを判定するフレーム数判定手段と、
前記フレーム数が所定数以上の場合は画面間符号化を実行するように制御する制御手段と、
をさらに具備することを特徴とする請求項１から請求項４のいずれかに記載の動画像符号化装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は、動画像を圧縮したり、圧縮された動画像を伸張するための動画像符号化装置に関し、特に、圧縮された動画像を伸張して鮮明な画像を出力するための動画像符号化装置に関する。

【０００２】

【従来の技術】この発明での動画像符号化装置とは、ＩＴＵ－Ｔ（International Telecommunication Union-Telecommunication sector）勧告のＨ．２６ｘやＩＳＯ／ＩＥＣ（International Standards Organization/International Electrotechnical Commission）標準のＭＰＥＧ（Moving Picture Experts Group）に代表される動画像符号化方式によって、動画像を符号化するための装置である。すなわち、動画像符号化装置は、動き補償および直交変換（たとえば、離散コサイン変換）等を用いてフレーム単位で符号化を実行する。

【０００３】ＩＴＵ－Ｔ勧告のＨ．２６ｘやＩＳＯ／ＩＥＣ標準のＭＰＥＧに代表される動画像符号化方式は、一般に、入力される映像信号に対して空間的および時間的相関関係により圧縮をかける。この圧縮により得られるデータをもとに、所定の順序にしたがってさらに可変長符号化を行い、符号列（ビットストリーム）を生成する。

【０００４】動画像符号化装置は、所定の符号化パラメータにしたがって指定された符号量のビットストリームを出力しなければならない。さらにデコーダ側のバッファにおいて、オーバーフローやアンダーフローが生じないように、エンコーダ側でデコーダ側のバッファの占有量を想定して発生符号量を制御しなくてはならない。このバッファは、ＶＢＶ（Video Buffering Verifier）バッファと呼ばれる。また、単に仮想バッファと呼ぶこともある。ＶＢＶバッファの容量は、ＭＰＥＧ－４ではプロファイルとレベルによって上限値が決まっている。発生符号量は、フレームをマクロブロック（ＭＢ：MacroBlock）ごとにＤＣＴが実行された結果得られた離散コサイン変換（ＤＣＴ：Discrete Cosine Transform）係数を量子化するために使用される量子化スケールにより制御される。一般に、発生符号量と量子化スケールとは反比例の関係にある。この性質を利用して発生符号量を自在に変化させることが可能である。

【０００５】しかし、一般的に量子化スケールには制限があるため、量子化スケールだけで発生符号量を制御することは不可能である。そこで、発生符号量が目標値よりも多い場合は、フレームスキップ数が増やされる。フレームスキップ数を増やすことで、符号化すべきフレームを遅らせ、ＶＢＶバッファのアンダーフローをふせぐことができる。また、発生符号量が目標値よりも少ない場合は、スタッフィングが実行される。スタッフィングは、冗長なビットを挿入することで、ＶＢＶバッファのオーバーフローをふせぐ。

【０００６】図１は、仮想バッファを制御する従来の方法を示す図であって、時間に対する仮想バッファのバッファ占有量を示す。フレームスキップの制御方法として

は、VBVバッファにある境界値(B(min))を設ける。これを下回る場合(図1に示される時刻t_4)はフレームスキップ数を増やし、境界値を越すまでスキップすることでバッファ量を増加させる。

【0007】

【発明が解決しようとする課題】しかしながら、この方法によると、発生符号量が多い状態が続く場合は、バッファ占有量が少ない状態が続き、バッファ占有量が境界値周辺を上下動する。たとえば、図1に示されている時刻t_4と時刻t_5のように上下動する。ゆえに、フレームスキップ数を増やしてバッファの回復を行う動作と所定のフレームスキップの動作とが繰り返される。その結果、フレーム間隔が不安定な状態となり見た目にも非常に品質が悪くなる。

【0008】さらに、画質の向上やエラー耐性、ランダムアクセス性を考慮して、ビットストリーム中にI-VOP(I-VOP:Intra-Video Object Plane)を挿入する場合がある。I-VOPは比較的符号量が多いため、頻繁にI-VOPを挿入すると、VBVバッファがアンダーフロー傾向になる。また、前記境界値周辺でI-VOPを挿入することにより急激にフレームスキップ数が増えるという問題がある。

【0009】そこで、これら従来における問題に鑑み、この発明の目的は、動画像の見た目の品質を向上させ、スムーズに安定した動画像が再生されることが可能になる動画像符号化装置を提供することである。

【0010】

【課題を解決するための手段】この発明によれば、復号側でのバッファの占有量を推測するための仮想バッファを参照しながら符号化を実行する動画像符号化装置において、1画像が画面内符号化されたときの発生符号量を推定する発生符号量推定手段と、前記1画像分の推定された発生符号量が取り去られたときの前記仮想バッファのバッファ占有量を推定するバッファ占有量推定手段と、前記推定されたバッファ占有量をもとづいて、フレームレートを推定するフレームレート推定手段と、所望のフレームレートを指定するフレームレート指定手段と、前記推定されたフレームレートと、前記指定されているフレームレートとの差が所定値以上か否かを判定するフレームレート判定手段と、前記判定されたフレームレートの差が所定値未満の場合は画面内符号化を実行し、前記判定されたフレームレートの差が所定値以上である場合は画面間符号化によって符号化を実行するように制御する符号化制御手段と、を具備することを特徴とする動画像符号化装置によって提供される。

【0011】この動画像符号化装置は、I-VOP符号化後の仮想バッファを予測し、その予測値から得られるフレームレートが現在のフレームレートから大きく変動するときは、I-VOPの符号化を行わない。

【0012】また、仮想バッファに複数の制御ポイントを設け、そのポイントごとに異なるフレームレートを設定するフレームレート更新部を設ける。この複数ポイントごとに設定されたフレームレートをビデオの符号化部に送り、符号化部は指定されたフレームレートにしたがって入力される画像をスキップし、符号化を行う。

【0013】さらに、仮想バッファのバッファ占有量から所定の時間内に含まれるべきI-VOPの数を制御し、バッファアンダーフローを抑制する。

【0014】

【発明の実施の形態】以下、図面を参照してこの発明の動画像符号化装置の実施形態を説明する。

(第1の実施形態)図2は、第1の実施形態における動画像符号化装置の電気的な内部構成を示す機能ブロック図である。この発明の動画像符号化装置は、符号化部1、出力バッファ2、仮想バッファ3、フレームレート更新部4、発生符号量制御部5、符号化モード設定部6、および装置制御部7からなる。

【0015】符号化部1は、符号化するべき画像信号を画像入力装置から入力する。画像入力装置は、ディジタルビデオカメラ、あるいは録画再生機器のような動画像信号の信号源である。入力した画像信号が、所定の動画像圧縮方式、すなわち、ISO/IEC標準のMPEG-4方式やITU-T勧告のH.263方式、またはこれらを変更した方式にしたがって、符号化される。符号化は、動画像圧縮方式にしたがって、入力した画像信号に含まれるフレームそれぞれを所定のマクロブロックに分割する。符号化モード設定部6から、各マクロブロックを符号化する符号化モード(イントラ符号化またはインター符号化)が入力される。

【0016】以下では、MPEG-4(Moving Picture Experts Group Phase 4)における動画像符号化方式について述べる。映像信号は、複数のビデオオブジェクトプレーン(VOP:Video Object Plane)から構成される。VOPは矩形状の場合、MPEG-1、2におけるフレームおよびフィールドに相当する。VOP単位で空間的および時間的相関関係により圧縮を行う。VOPは、輝度信号と色差信号を有して、複数のMBから構成される。MBは、輝度信号に対して縦横16画素からなる。空間的圧縮および時間的圧縮は、このMB単位に実行される。空間的圧縮では、DCTと量子化によって画像が圧縮される。時間的圧縮では、動き補償(MC:Motion Compensation)によって、画像が圧縮される。

【0017】VOP単位の圧縮方法には、空間的圧縮のみで符号化される画面内符号化(イントラ符号化)と、空間的圧縮と時間的圧縮によって符号化される画面間符号化(インター符合化)がある。画面内符号化されたVOPは、I-VOP(Intra-VOP)と呼ばれる。画面間符号化されたVOPは、P-VOP(Predictive-VOP)とB-VOP(Bi-directionally predictive-VOP)との2種類がある。P-VOPは、参照VOPとして時間

的に前に符号化されたＶＯＰのみが参照されたＶＯＰであって、片方向のＭＣが実行されて、符号化されたＶＯＰである。また、Ｂ－ＶＯＰは、参照ＶＯＰとして時間的に前後に符号化されたＶＯＰが参照されたＶＯＰであって、双方向のＭＣが実行されて、符号化されたＶＯＰである。ここで参照ＶＯＰとは、過去にＩ－ＶＯＰまたはＰ－ＶＯＰとして符号化され画面間符号化で用いるために復号されたＶＯＰの中で、現在符号化すべきＶＯＰに対して時間的に隣接するＶＯＰである。１度の画面間符号化では、高々２つのＶＯＰが参照される。また、Ｉ－ＶＯＰに含まれるＭＢは、すべてイントラで符号化されなければならない。一方、ＰおよびＢ－ＶＯＰに含まれる各ＭＢは、イントラ、インターのどちらを用いて符号化されても良い。ここで、「ＶＯＰを画面内符号化する」、「ＶＯＰをイントラ符号化する」、および「Ｉ－ＶＯＰで符号化する」は、すべて同様の内容を示す。したがって、このいずれの表現も内容的な違いはなく、同様の内容を意味する。

【００１８】以下、ＭＢ単位の符号化処理を簡単に述べる。符号化すべきＭＢを含むＶＯＰがＩ－ＶＯＰの場合は符号化部１が、輝度信号と色差信号について、量子化されたＤＣＴ係数を可変長符号化により圧縮する。量子化されたＤＣＴ係数は、輝度信号と色差信号とについて、ＤＣＴと量子化とが実行されて算出される。そして、ヘッダ情報とともに所定の順序にしたがってビットストリームを作成する。

【００１９】一方、符号化すべきＭＢを含むＶＯＰがＩ－ＶＯＰ以外の場合は符号化部１が、符号化すべきＭＢとの輝度信号における差分値（ＭＣ誤差）が最も小さくなる参照ＶＯＰ上のＭＢが探し出される。参照ＶＯＰは、符号化すべきＭＢを含むＶＯＰに対して、時間的に隣接している符号化されたＶＯＰである。参照ＶＯＰ上のＭＢで、符号化すべきＭＢとの輝度信号における差分値（ＭＣ誤差）が最も小さくなるような、ＭＢが探し出される。このＭＢを探し出すために、ブロックマッチングに代表される動き検出法が使用される。符号化すべきＭＢからＭＣ誤差が最も小さくなるＭＢまでの動きを示すベクトルが生成される。このベクトルは、動きベクトルと呼ばれる。ＭＣ誤差に対して、ＤＣＴと量子化とが実行される。得られた動きベクトルと、輝度信号および色差信号のＭＣ誤差について量子化されたＤＣＴ係数とを可変長符号化により圧縮する。これら圧縮された動きベクトルと量子化されたＤＣＴ係数とが、ヘッダ情報とともに所定の順序にしたがってビットストリームとして生成される。

【００２０】また、フレームレート更新部４から、出力される動画像のフレームレートを指定する制御信号が符号化部１に出力される。さらに、発生符号量制御部５から、符号化によって発生する符号量の目標値を指定する制御信号が符号化部１に出力される。これら、フレームレートと発生符号量の目標値とが指定されて、符号化部１はフレームスキップまたはスタッフィングを実行する。そして、可変長符号化された符号列は、出力バッファ２に出力される。

【００２１】出力バッファ２は、符号化部１で符号化された符号化列を、目標のビットレートで出力する。このビットレートは、装置制御部７で設定される。また、ＶＯＰの発生符号量を算出し、算出された発生符号量を仮想バッファ３と発生符号量制御部５に出力する。

【００２２】仮想バッファ３は、装置制御部７で設定されたバッファ占有量の初期値（図１のB_0）がバッファ占有量に設定される。最初のフレームの符号化後、出力バッファ２から得られる最初のフレームの発生符号量（図１のｄ０）を、バッファ占有量から減少させる（図１のB'_0）。その後、つぎに符号化するフレームまでの時間（図１のＴ：フレーム間隔）にビットレートを乗じた値を、バッファ占有量に増加させる（図１のB_1）。これ以降、出力バッファ２から得られる発生符号量を、バッファ占有量から減少させ、つぎのフレーム間隔にビットレートを乗じた値を、バッファ占有量に増加させる、ということをフレームごとに実行する。また、仮想バッファ３は、時刻ごとのバッファ占有量を、フレームレート更新部４、発生符号量制御部５、および符号化モード設定部６へ与える。

【００２３】フレームレート更新部４は、１枚分の符号量が取り去られた後のバッファ占有量を検査し、あらかじめ設定されたフレームスキップを実行するバッファ占有量に対応するしきい値（制御ポイント）に応じたフレームレートを符号化モード設定部６および符号化部１に出力する。複数の制御ポイントに応じたフレームレートを符号化モード設定部６および符号化部１に出力する。

【００２４】発生符号量制御部５は、出力バッファ２から得られる符号化したＶＯＰの発生符号量と、符号化したＶＯＰの量子化スケールの平均値とを、符号化モード別に記憶し、これを符号化モード設定部６へと与える。また、つぎに符号化すべきＶＯＰ符号化モードを、所定の規則（たとえば、ＭＰＥＧ－２のＧＯＰ構造）や後述する動画像の変化を考慮して決定し、これを符号化モード設定部６へと与える。また、仮想バッファ３のバッファ占有量から、つぎに符号化すべきＶＯＰの量子化スケールやスタッフィングビット数などを、符号化部１へと与える。

【００２５】符号化モード設定部６は、発生符号量制御部５で決定された符号化モードで符号化された場合の発生符号量を推定する。この符号量と、仮想バッファ３から得られるバッファ占有量とから符号化後の仮想バッファ３のバッファ占有量を推定する。そして、推定されたバッファ占有量に対応するフレームレートに適する符号化モードを指定する制御信号を符号化部１に出力する。

【００２６】装置制御部７は、符号化部１、出力バッフ

ァ２、仮想バッファ３、フレームレート更新部４、および発生符号量制御部５を制御する。たとえば、装置が出力すべきビットストリームの制御をする。具体的には、目標となる発生符号量（目標ビットレート）を発生符号量制御部５に指示する。発生符号量制御部５は、この目標ビットレートに合うように、符号化部１に様々な符号化パラメタ（量子化スケール、スタッフィングビット数、符号化モード、およびフレームスキップ数）を与え、発生符号量を制御している。また、目標となる、単位時間当りのフレーム数（目標フレームレート）をフレームレート更新部４に指示する。さらに、仮想バッファ３に初期遅延量の値を指示する。また、誤り耐性などの符号化モードの設定条件を発生符号量制御部５に設定する。さらに、制御ポイントを設定してもよい。また、装置制御部7は、装置に入力される画像信号の制御も実行する。

【００２７】図3は、符号化後のフレームレートを推定することによって、符号化する方式を設定するフロー図である。

【００２８】画質の向上やエラー耐性、ランダムアクセス性を考慮して、ビットストリーム中にＩ－ＶＯＰで符号化されることがある。一般的に、Ｐ－ＶＯＰやＢ－ＶＯＰで符号化を行うよりも、Ｉ－ＶＯＰで符号化を行う方が発生する符号量は多くなることが知られている。

【００２９】したがって、頻繁にＩ－ＶＯＰを挿入すると、仮想バッファ３がアンダーフロー傾向になる。特に、バッファ占有量が低い場合（たとえば、図１、図4または図5のＢ（ｍｉｎ）の場合）で比較的発生符号量の多いＩ－ＶＯＰで符号化を行うと、Ｂ（ｍｉｎ）を下回り、フレームスキップ数が急激に増加し、目標フレームレートが急激に小さくなる場合が起こりうる。このように目標フレームレートが急激に変動している符号化された動画像を、ユーザが見た場合、見栄えが悪いと感じることが多い。そこで、Ｉ－ＶＯＰの挿入により目標フレームレートが急激に変動してしまう場合には、Ｉ－ＶＯＰで符号化をしないように制御する。

【００３０】動画像の符号化が開始されると、ステップＳＴ－Ａ１でＶＯＰをイントラ符号化するか否かが判定される。この判定は、発生符号量制御部５が実行する。たとえば、動画像が劇的に変化する（シーンチェンジ）場合は、ＶＯＰをイントラ符号化する等の制御をする。発生符号量制御部５がＶＯＰをイントラ符号化すると判定した場合は、ステップＳＴ－Ａ３に進む。一方、発生符号量制御部５がＶＯＰをイントラ符号化しないと判定した場合は、ステップＳＴ－Ａ２に進む。

【００３１】ステップＳＴ－Ａ２では、ＶＯＰをインター符号化する。ここでは、Ｐ－ＶＯＰに符号化する。また、Ｐ－ＶＯＰだけでなく、Ｂ－ＶＯＰに符号化するように設定されてもよい。また、発生符号量制御部５が判断して、Ｐ－ＶＯＰまたはＢ－ＶＯＰのいずれかに符号化するように設定してもよい。さらに、後述するようにステップＳＴ－Ａ３、およびＳＴ－Ａ４においてＩ－ＶＯＰについて実行されることをＰ－ＶＯＰについても実行されてもよい。すなわち、Ｐ－ＶＯＰで符号化後のフレームレートが推定されて、このフレームレートが所定値以上である場合は、Ｂ－ＶＯＰで符号化するように設定されていてもよい。

【００３２】ステップＳＴ－Ａ３では、Ｉ－ＶＯＰに符号化後のフレームレートを推定する。そして、ステップＳＴ－Ａ４では、ステップＳＴ－Ａ３で推定されたフレームレートと所望のフレームレートとの差が、所定値より小さいか否かが判定される。すなわち、ステップＳＴ－Ａ３で推定されたフレームレートがその直前のフレームレートに比較して急激に変化しているか否かが判定される。この場合は、その差が所定値よりも小さい場合は、フレームレートが急激に変化していないと判定されることになる。この所定値は、装置制御部7によって与えられる。ステップＳＴ－Ａ４で、ステップＳＴ－Ａ３で推定されたフレームレートと所望のフレームレートとの差が、所定値より小さい場合は、ステップＳＴ－Ａ５に進む。一方、ステップＳＴ－Ａ３で推定されたフレームレートと所望のフレームレートとの差が、所定値より小さくない場合は、ステップＳＴ－Ａ２に進む。

【００３３】フレームレートを推定するには、Ｉ－ＶＯＰで符号化後の仮想バッファ３のバッファ占有量を知る必要がある。すなわち、Ｉ－ＶＯＰで符号化した場合の符号量が必要になる。そこで、以前に符号化したＩ－ＶＯＰの符号量とその量子化スケールの平均値とから、符号化モード設定部6がＩ－ＶＯＰの符号量を推測する。この推測されたＩ－ＶＯＰの符号量と、符号化直前の仮想バッファ３のバッファ占有量とにより、Ｉ－ＶＯＰに符号化した場合の仮想バッファ３のバッファ占有量を計算して推測することが可能になる。バッファ占有量が推測されると、フレームレートを推定することができる。

【００３４】ステップＳＴ－Ａ５では、Ｉ－ＶＯＰで動画像を符号化する。そして、つぎのＶＯＰを符号化するために、ステップＳＴ－Ａ１に戻る。そして、全ての動画像を符号化するまで、上記ステップを繰り返す。

【００３５】図4は、従来の方法によってある動画像を符号化する場合での、時間に対する仮想バッファ３のバッファ占有量の一例を示す図である。図5は、図4に示されるように符号化される動画像を、第１の実施形態における動画像符号化装置を使用して符号化した場合の、時間に対する仮想バッファ３のバッファ占有量を示す図である。

【００３６】図3に示したフロー図にしたがって符号化を実行することにより、図4でＶＯＰをイントラ符号化している時刻t_Iで、ＶＯＰをイントラ符号化しないでＰ－ＶＯＰ符号化した場合を図5は示している。すなわち、図4および図5に示されている時刻t_Iにおいて、

図4では、I－VOPに符号化しているが、図5では、P－VOPに符号化している。

【0037】図5では、図3に示したようにI－VOPに符号化した後のフレームレートを推定して、そのフレームレートの変化が所定値以内である場合には、I－VOPに符号化される(図5の時刻t'_I)。図4に示される時刻t_IでI－VOP符号化されると、フレームスキップが図4に示されるように、I－VOPに符号化される前後で大きく変動する。図5では、時刻t_Iで符号化する時点で図3に示される方法により、時刻t_Iの前後ではI－VOPに符号化されるとフレームレートが大きく変動してしまうことを避けるために時刻t_IではP－VOPに符号化する。

【0038】その結果、図4に示されるように時刻t_Iの前後に見られるようなフレームスキップ数の変動はなくなり、変動の少ないフレームスキップを得ることが可能になる。したがって、動画像全体を通じて画質向上を実現することが可能になる。

【0039】(第2の実施形態) この発明の第2の実施形態に係る動画像符号化装置の構成は、第1の実施形態に係る動画符号化装置の構成と同様である。すなわち、この発明の動画像符号化装置は、符号化部1、出力バッファ2、仮想バッファ3、フレームレート更新部4、発生符号量制御部5、符号化モード設定部6、および装置制御部7からなる。ただし、フレームレート更新部4および発生符号量制御部5の動作が異なる。以下、この相違点を中心にして第2の実施形態を説明する。

【0040】図6は、この発明の第2の実施形態における時間に対する仮想バッファ3のバッファ占有量を示す図であって、フレームスキップを実行するバッファ占有量に対応するしきい値(制御ポイント)を3段階設定した場合(図6に示されているB1、B2、およびB(min))の時間に対する仮想バッファ3のバッファ占有量の履歴(破線)と、制御ポイントを1つのみ設定した場合(図6に示されているB(min))の時間に対する仮想バッファ3のバッファ占有量の履歴(実線)とを示す図である。

【0041】図6の破線に示されている例では、上記のしきい値である制御ポイントが3段階設けられている。一番大きな値としてB1、つぎに大きな値としてB2、最終的な限界値としてB(min)が設定されている。B(min)は、1画像がインター符号化された程度の大きさであり、B1とB2との差、およびB2とB(min)との差も1画像がインター符号化された程度の大きさである。しかし、これらの値は特に限定する必要はなく、動画像符号化装置の製造者が所望の値に自在に設定することが可能である。仮想バッファ3内のバッファ占有量は、フレームレート更新部4に入力され、3段階に設定された制御ポイントに応じた目標フレームレートを符号化モード設定部6および符号化部1に出力する。

【0042】また、目標フレームレートをたとえば、秒15枚とする。すなわち、通常の制御では、符号化するフレーム間隔が2枚ごとスキップする枚数は1枚という設定で符号化を実行する。フレームレート更新部4には通常動作でのスキップ枚数は1、B1を下回った場合のスキップ枚数は2、B2を下回った場合のスキップ枚数は3、B(min)を下回った場合はバッファが回復するまでのスキップ枚数だけスキップするという条件が入力されている。

【0043】図6に示されている最初の状態(時間が0からt_3まで)では、バッファ占有量が十分であるため制御ポイントを設定しない場合(実線の履歴)、および制御ポイントを設定する場合(破線の履歴)ともに同様なバッファ占有量の履歴を示す。t_0からt_3まで、一定の時間間隔Tを保っている。この時間間隔(フレームスキップ)は、フレームレートに反比例している。ゆえに、図6のt_0からt_3までフレームレートは、秒15枚をキープし、1枚スキップしながら符号化されている。時刻t_3において、第1の制御ポイントB1を下回る。したがって、フレームレート更新部4においてB1に対応するスキップ枚数2が選択される。すると、フレームスキップ数が増える。換言すれば、フレームレートが遅くなる。図6では、つぎに符号化される時刻をt'_4とすると、$t'_4-t_3>T$になる。その後のt'_4、t'_5、t'_6では、それぞれスキップ枚数が3、2、3と続く。このように、図6に示した符号化例では、制御ポイントを3つ設定した場合は、フレームスキップ数は、3枚より多くなっていない。したがって、全体を通してB(min)を下回る機会が著しく減少し、大きなフレームスキップを必要としなくなる。

【0044】一方、制御ポイントB1およびB2が設定されていない場合は、時刻t_3において、スキップ枚数は1のままである。そして、この場合は、つぎに符号化する時刻t_4においてB(min)を下回る。ゆえに、バッファアンダーフローを防ぐために、大きなフレームスキップが実行される。図6の場合は、スキップ枚数は3枚より多くなってしまう。また、B(min)以上のスキップ枚数は常に1であるので、符号量の多いフレームがあると時刻t_6の場合のように、バッファ占有量が再びB(min)を下回ってしまう場合が頻発しうる。その結果、フレームスキップ数が1と3の間をゆらぎ、フレームスキップ数の変動が大きくなる。また、この場合であれば、B1の制御ポイントの周辺を行ったり来たりする場合でも、フレームスキップ数の変動は1枚ですむため、見た目には大きな変動を感じさせずにすむ。

【0045】以上のように、制御ポイントが複数ある場合は、制御ポイントが1つしかない場合に比較して、フレームスキップ数のゆらぎの大きさが小さい。したがって、見た目には大きな変動を感じさせずにすむ。バッファ占有量のフレームスキップ数が1枚ずつ段階的に変化

するように設定されているので、フレームスキップ数が突然2枚変化する可能性は、制御ポイントが1つしかない場合に比較して格段に少なくなる。さらにはバッファ占有量が全体を通して高い値で推移するため量子化スケール値を粗くすることも少なくなり、全体を通した画質向上を実現できる。

【0046】図7は、図3の工程に加えて、過去の所定時間内のイントラ符号化されたVOPの数を確認することによって符号化する方式を設定する工程を含むフロー図である。

【0047】第1の実施形態での符号化の動作を示すフローに1つのステップが加わったものが第2の実施形態での符号化の動作を示すフローである。すなわち図3のステップST－A1とステップST－A3との間に新たなステップが付加される。新たなステップは、頻繁にI－VOPで符号化されないようにするためのものである。

【0048】上述したように、一般的にP－VOPやB－VOPで符号化を行うよりも、I－VOPで符号化を行う方が発生する符号量は多くなる。したがって、頻繁にI－VOPを挿入すると、仮想バッファ3がアンダーフロー傾向になる。たとえば、動画像が劇的に変化するシーンチェンジの場合は、VOPをイントラ符号化することが多く、シーンチェンジが頻出する場合は仮想バッファ3がアンダーフロー傾向になりやすい。そこで、I－VOPを頻繁に挿入しないように制御する。その方法として第2の実施形態では、ある一定時間内で符号化されたVOPのうち、I－VOPで符号化される最大のVOP数を制限する。

【0049】具体的には、発生符号量制御部5がVOPをイントラ符号化すると決定した場合に、ステップST－B1からステップST－B3に進む。ステップST－B3では、過去の所定時間内にI－VOPに符号化されたVOP数をあらかじめ設定してある所定数と比較する。I－VOPに符号化されたVOP数が所定数以上である場合には、バッファ占有量が小さくバッファアンダーフローが発生しやすい状態であるとみなす。この場合は、I－VOPに符号化せず、P－VOPで符号化する（ST－B2）。また、設定してある所定数は、通常、仮想バッファ3の大きさに依存して決定される。過去の所定時間内のI－VOP数は、たとえば符号化モード設定部6がカウントしておき、VOPが符号化されるごとにアップデートされるように設定しておく。

【0050】この結果、ステップST－B3によって、I－VOPが頻繁に挿入され仮想バッファ3がバッファアンダーフロー傾向になることを抑制することができる。

【0051】ほかのステップは、すべて第1の実施形態で示した図3と同様である。

【0052】図8は、図6に示されたしきい値を設定して、図7のフロー図に示される方法を使用して、動画像を符号化した場合の、時間に対する仮想バッファ3のバッファ占有量を示す図である。

【0053】バッファ占有量が時刻t_1、t_2、t_3等のB1またはB2以下にある場合は、B2以上B1未満、B（min）以上B2未満、B（min）未満にしたがって、段階的にフレームスキップ数が多くされる。その結果、隣同士のフレームでは、スキップする枚数に最大1枚の差があるだけである。ところで、バッファ占有量がB（min）未満の場合は、隣のフレームとの間でスキップする枚数差が1枚以上である可能性はある。しかし、B（min）以上のしきい値B1およびB2で段階的にフレームスキップ数が増加されているので、スキップ枚数差が2枚以上になる場合は少ない。したがって、ユーザは、見た目に画像が大きく変動することなく、スムーズに安定した動画像を見ることが可能になる。また、バッファ占有量が全体を通して高い値で推移するため量子化スケール値を粗くすることも少なくなり、全体を通した画質向上を実現できる。

【0054】また、バッファ占有量に無関係に、ある一定時間内で符号化されたVOPのうち、I－VOPで符号化される最大のVOP数を制限している。さらに、あるVOPを符号化する際に、フレームレートがどう変化するかを推定して、その推定されたフレームレートにしたがって、イントラ符号化をするかインター符号化をするかが決定される。したがって、フレームレートが急激に低下することを避けることができる。ゆえに、バッファアンダーフローを防ぐことが可能になる。また、フレームスキップ数が急に増えることも防ぐことができる。その結果、ユーザは、見た目に画像が大きく変動することなく、スムーズに安定した動画像を見ることが可能になる。また、バッファ占有量が全体を通して高い値で推移するため量子化スケール値を粗くすることも少なくなり、全体を通した画質向上を実現できる。

【0055】この発明は、上述した実施の形態に限定されるものではなく、その技術的範囲において種々変形して実施することができる。

【0056】

【発明の効果】この発明の動画像符号化装置によれば、フレームスキップ数が大きく変動することを避けることができるので、見た目に画像が大きく変動することなく、スムーズに安定した動画像を見ることが可能になる。

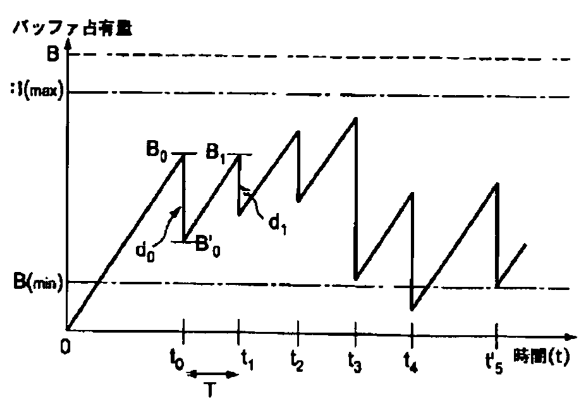
【0057】また、バッファ占有量が全体を通して高い値で推移させることが可能になる。したがって、量子化スケール値を粗くすることも少なくなり、全体を通した画質向上を実現できる。

【図面の簡単な説明】

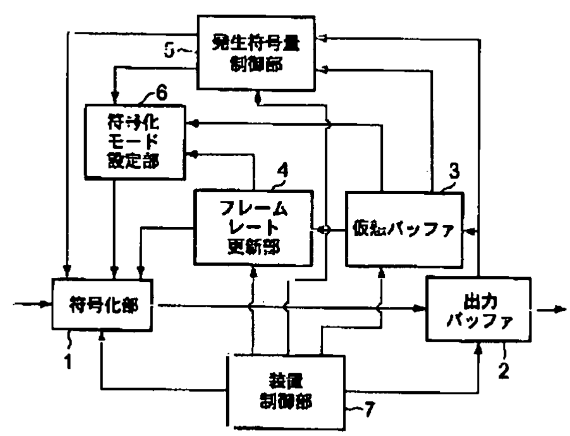
【図1】仮想バッファを制御する従来の方法を示す図であって、時間に対する仮想バッファのバッファ占有量を

示す図である。
【図2】この発明の実施形態における動画像符号化装置の電気的な内部構成を示す機能ブロック図である。
【図3】この発明の第1の実施形態における符号化する方式を設定するための手順を示すフロー図であって、符号化後のフレームレートを推定することによって、符号化する方式を設定するフロー図である。
【図4】従来の方法によってある動画像を符号化する場合での、時間に対する仮想バッファのバッファ占有量の一例を示す図である。
【図5】図4に示されるように符号化される動画像を、この発明の第1の実施形態における動画像符号化装置を使用して符号化した場合の、時間に対する仮想バッファのバッファ占有量を示す図である。
【図6】この発明の第2の実施形態における時間に対する仮想バッファのバッファ占有量を示す図であって、フレームスキップを実行するバッファ占有量に対応するしきい値（制御ポイント）を3段階設定した場合の時間に対する仮想バッファのバッファ占有量の履歴（破線）と、制御ポイントを1つのみ設定した場合の時間に対する仮想バッファのバッファ占有量の履歴（実線）とを示す図である。
【図7】この発明の第2の実施形態における符号化する方式を設定するための手順を示すフロー図であって、図3の工程に加えて、過去の所定時間内のイントラ符号化されたVOPの数を確認することによって符号化する方式を設定する工程を含むフロー図である。
【図8】図6に示されたしきい値を設定して、図7のフロー図に示される方法を使用して、動画像を符号化した場合の、時間に対する仮想バッファのバッファ占有量を示す図である。
【符号の説明】
1　符号化部
2　出力バッファ
3　仮想バッファ
4　フレームレート更新部
5　発生符号量制御部
6　符号化モード設定部
7　装置制御部

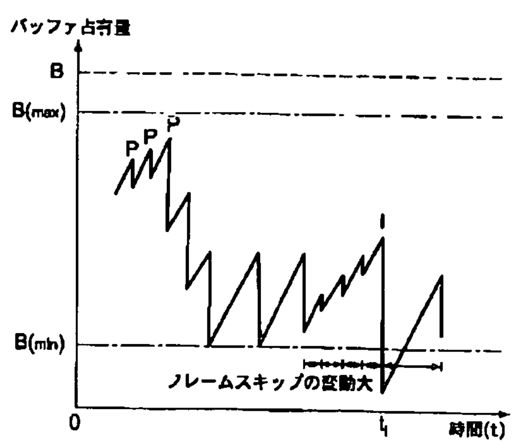
【図1】



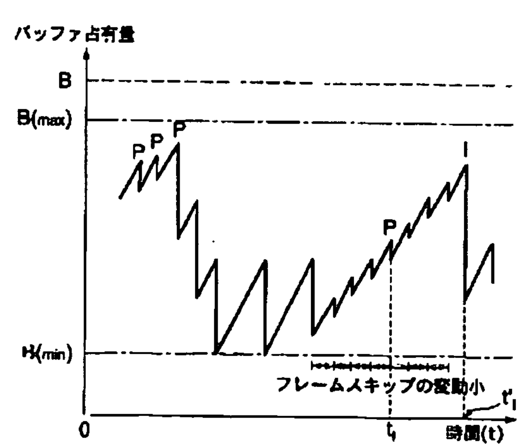
【図2】



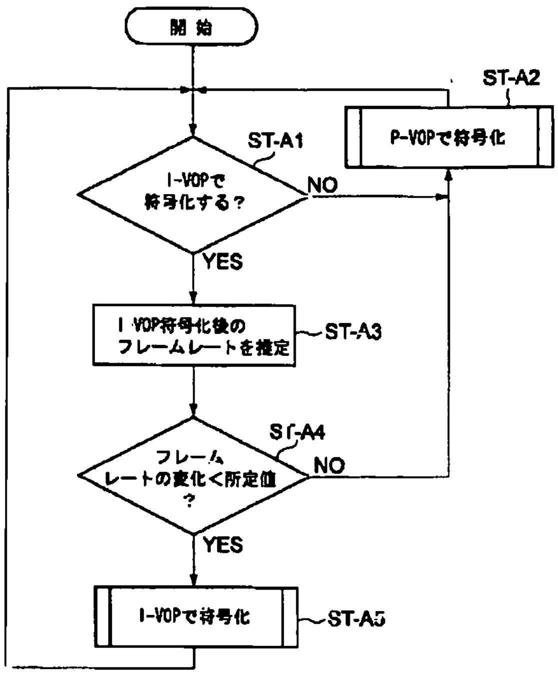
【図4】



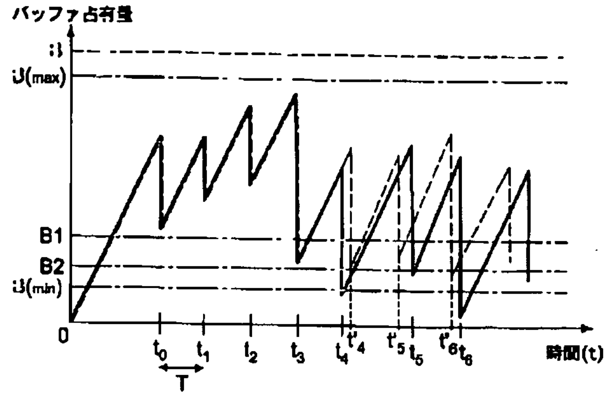
【図5】



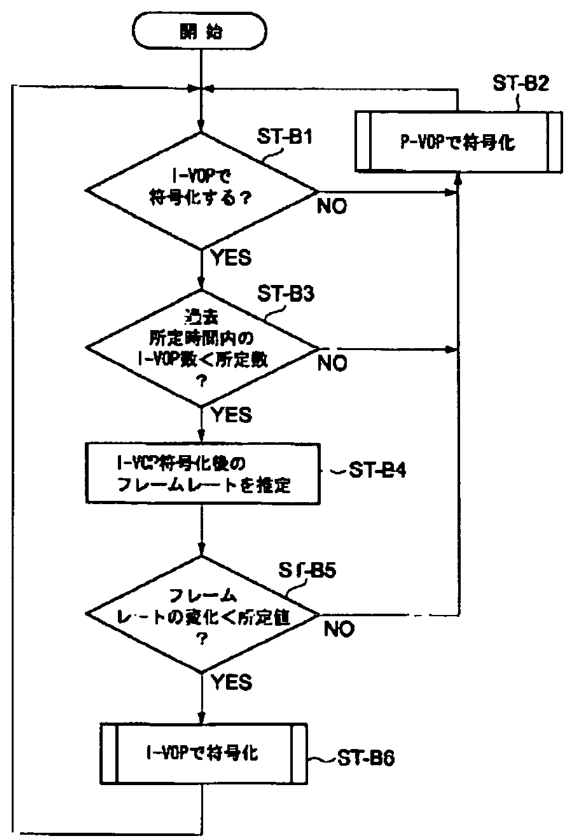
【図3】


開始
ST-A1
I-VOPで符号化する？
NO
YES
ST-A2
P-VOPで符号化
I-VOP符号化後のフレームレートを推定
ST-A3
ST-A4
フレームレートの変化＜所定値？
NO
YES
I-VOPで符号化
ST-A5

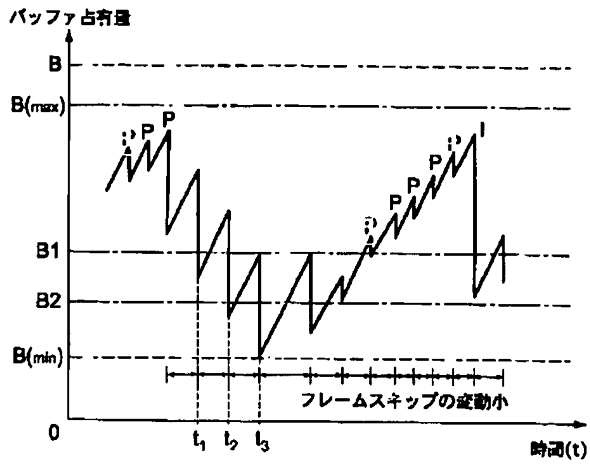
【図6】


バッファ占有量
B(max)
B1
B2
B(min)
0
t_0 t_1 t_2 t_3 t_4 t'_4 t'_5 t_5 t'_6 t_6
T
時間(t)

【図7】


開始
ST-B1
I-VOPで符号化する？
NO
YES
ST-B2
P-VOPで符号化
ST-B3
過去所定時間内のI-VOP数＜所定数？
NO
YES
I-VOP符号化後のフレームレートを推定
ST-B4
ST-B5
フレームレートの変化＜所定値？
NO
YES
I-VOPで符号化
ST-B6

【図8】



フロントページの続き

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